8.0 OPERATING CONDITIONS

8.1 GENERAL

This section describes the various operating conditions including start-up, operation, maintenance requirements and safety issues of an LFG management system such as a flare/blower station. LFG treatment systems, if incorporated, usually involve more complex operation schemes. The operation and control for those systems are site-specific and will not covered in this ETL because of limited use in military installations.

Typically, start-up and the first year of operation and maintenance (O&M) of an LFG control system for military landfills are performed by the contractor. The start-up procedures, however, are described here for reader information.

In general, a start-up plan (or procedure) should be prepared for the entire LFG control system. The start-up plan should take into account the system's design objectives and complexity and will encompass:

- prestart-up checkout,
- prestart-up testing, and
- the actual start-up.

The prestart-up is just a reinspection prior to prestart-up testing because during construction, each component has been inspected for proper installation by a field inspector using a construction check-list. The purpose of the prestart-up checkout is to verify that the components of the system are properly installed according to plans and drawings. The system's Piping and Instrumentation Diagram (P&ID) and the As-Built Drawings are the best documents to use to verify that all equipment, piping, and valves are installed. The electrical One-Line Diagrams and Wiring Diagrams are useful to verify electrical and instrumentation systems. Grounding of equipment should also be checked. Vendor's certified shop drawings and operating manuals for equipments are important documents to check the equipment installation and operation.

The pre-startup testing is designed to verify integrity of the system prior to actual operation. Components subjected to the prestart-up testing may include:

- piping and ducts should be tested for pressure or vacuum to the design requirements;
- blower, condensate pumps should be tested for operability;
- electrical wiring, and lighting should be tested for continuity and/or damage;
- analog control, if installed, are tested with simulated signal to verify operating ranges; and
- valves are checked for position and operability;
- flare fuel-assisted equipment should be tested for operability, and
- Where on-line gas and liquid sampling instruments are being used, calibrate the instruments after all other system components have been tested.

The actual start-up can begin once the prestart-up testing is complete. The start-up should proceed slowly following a start-up plan prepared well in advance. This is extremely important because LFG is toxic and flammable. Pieces of equipment that can be operated without process liquid or vapor should be started first. All equipment to be on "Stand-by" during full operation should be started before process equipment is started. Once steady-state operation is achieved, operation activities will continue to assure smooth operation.

The maintenance is comprised of a series of activities carried out to ensure that equipment, systems and facilities are able to perform as intended and/or to provide consistent performance of the treatment equipment.

The following sections describe start-up operations of an LFG collection and control using a flare-blower station. The start-up procedure proceeds following a planned sequence of events on each component of the collection system.

8.2 WELLS

8.2.1 Prestart-up Checkout.

Prior to initiating start-up of the gas wells, each gas well will be reinspected for completion by the engineer against the checklist completed during the construction and quality control. All wells will be inspected against construction drawings to verify that there are no outstanding construction issues.

8.2.2 Prestart-up Testing

Pretesting may include pressure or vacuum tests and/or valve rating tests. The prestart-up testing on the wells can be omitted if it has been checked and tested by the field inspector during construction and there are no modification or off-specification materials used in the construction.

8.2.3 Start-up

During start-up, each wellhead valve will be fully open. It is possible to optimize the composition of the recovered gas (percent methane) by making adjustments based on the chemical analyses of the landfill gas at different well heads. Observation, sampling and pressure and flow rate measurements at the wellhead will be compared to design parameters to ensure that the system is operating as expected.

Once the system is running at or close to the expected set points, the entire system should be checked. Monitoring data includes the flow, the pressure, and the temperature at each extraction well and at all test points in the system. The operating data are then compared to equipment performance for discrepancies.

At least two sets of measurements should be taken at each well for the first 3 to 4 days of start-up to adjust the valves to maintain the desired percent CH_4 and/or O_2 at the wellhead. After 3 to 4 days, the observations and necessary adjustments

will be reduced to one observation per day for the next 10 to 14 days. Following this first 2-week adjustment period, observations should be made every other day for an additional 2 weeks.

As discussed in the previous chapters, military solid waste landfills usually do not produce a high percent CH_4 as do MSW landfills, therefore adjustment of valves for steady-state operation should be based on chemical analyses of the system, i.e., oxygen content in the LFG. An oxygen content less than five percent should be maintained at the well head to prevent underground fire and or explosion.

Monitoring of pressure and flow rate on multiple wellheads will require one internal and one perimeter well to be selected from each landfill area for monitoring. Flow rate will be measured at the flow meter installed on the wellhead. The monitors should be spaced at distances from each wellhead measuring 25, 100 and 200 feet from the well selected for testing. Monitoring frequencies specified above for the gas wells apply also to these monitoring locations.

Information that will be collected includes:

- gas flow rates;
- applied vacuum;
- barometric pressure;
- temperature; and
- baseline chemical quality parameters CH_4, CO_2 and O_2

All data collected and conditions observed will be noted in a log so that future monitoring activities can be referenced to these baseline conditions. Additional monitoring recommendations and sampling methodologies are provided in the LFG Collection System Monitoring Plan as described in Section 4.7.

8.3 COLLECTION LATERAL

8.3.1 Prestart-up Checkout

The laterals will be inspected by the field engineer to ensure all isolation valves and monitoring station valves are fully open. All vacuum gauges installed at various locations on the wells and manifold network are checked for proper operation and set points.

8.3.2 Prestart-up Testing

Safety shut down conditions will be tested manually to inspect the proper operation of safety shut down sequences. These conditions will apply principally to the blower and flare unit systems.

8.3.3 Start-up

Pressure. and flow rate measurements will be obtained at each collection lateral monitoring station and be compared to design parameters. Monitoring frequencies for the collection lateral should coincide with that of the gas wells.

8.4 CONDENSATE COLLECTION SYSTEM

8.4.1 Prestart-up Checkout

Before start-up of the condensate collection system, each of the remote sumps will be inspected to ensure that the pump is properly installed. High liquid level alarms as well as pump on/off level controls should be checked for proper installation. The central knock-out pot will be inspected to ensure that the tank and pumps are in satisfactory condition and that the discharge valves are positioned to permit free drainage of condensate to the condensate storage tank.

8.4.2 Prestart-up Testing

The pumps in the remote sumps as well as the condensate storage tank will operate on levels with operating ranges as projected on the construction drawings. Actual pump cycle times will be dependent on the rate of condensate collection which may not meet design predictions. These pumps can be inspected for operation using tap water. Should condensate levels build-up to unacceptable levels in the tank (i.e., 80 percent), condensate must be removed and hauled to a disposal facility. Safety

shutdown conditions will be initiated manually and proper operation of safety shutdown sequences will be inspected.

8.4.3 Start-up

Start-up of the condensate collection system begins after all components of this system have been tested and certified for operation. Once steady-state operation is achieved, operational efficiency data will be collected at each sump. Information that will be collected includes:

- condensate generation rates, and
- pump cycles.

Conditions will be noted in a log so that future monitoring activities can be referenced to these baseline conditions.

8.5 BLOWER

The following activities relate to all three-phases of the start-up for the blower.

8.5.1 Prestart-up Checkout

Prestart-up checkout of the blower is performed by the field engineer to ensure that the unit is properly installed. Control devices such as a clock that record cumulative hours of run-time, an odometer that records the number of cycles should be checked for proper setting. The blower should also be checked for proper oil level and ready for start-up.

8.5.2 Prestart-up Testing

Safety shut down conditions will be initiated manually to inspect proper operation of safety shut down sequences. Noise level will be measured to check compliance with OSHA regulation (85 dB at 5 feet).

8.5.3 Start-up

During start-up, the pressure controls on the blower will be adjusted for minimum vacuum to identify any defects in the blower assembly. The vacuum pressure will be slowly increased to permit the system to stabilize incrementally. Incremental increase in pressure permits periodic inspection of the gas wells and collection lateral system. Following incremental

increase to full operating conditions, the gas well balancing activities will be initiated.

During start-up, blower amperage should be monitored to determine the load placed on the blower. Excessive amperage may indicate low flow and/or high vacuums across the blower, which could lead to overheating. Excessive amperage may also indicate that the blower is undersized. Operating conditions such as the flow rate, operating pressure and pressure drops should be noted on a log for future monitoring activities. Additional monitoring needs are discussed in the LFG Collection System Monitoring Plan, Section 4.7.

8.6 FLARE AND APPURTENANCE

8.6.1 Prestart-up Checkout

Prestart-up checkout of the flare is performed by the field engineer to ensure that the unit is properly installed. In addition, flare appurtenances such as the flame arrestor, the flame detector, the fuel-assisted device, and the water seal tank should be verified for proper installation. The flame arrestor seals should be checked on both ends. The temperature control devices on the flare should be checked for proper setting.

8.6.2 Prestart-up Testing

The flame detector safety shut down conditions of the inlet valve due to flare temperature will be initiated manually to inspect proper operation of safety shut down sequences. The pilot light will also tested for operability.

8.6.3 Start-Up

Start-up procedures for control devices should follow those prescribed by the manufacturer. Pressure drop across the flame arrestor shall be measured to ensure compliance with design level (AP < 3').

Once steady-state operation is achieved, condensate aspiration will commence and plans will be made for implementing the flare compliance test as described in the specification.

8.7 MODE OF OPERATIONS

8.7.1 Manual Operation

An landfill off-gas collection and control systems designed for manual operation will employ the least complex degree of automation while maximizing operator interface. Controls will be limited to local monitoring of system pressures, temperatures, flow and gas composition. Valves used to throttle flow and balance the collection system will be equipped with manual operators. Condensate collection and control systems can employ manual drainage devices.

Generally, designs incorporating manual operation would be limited to collection and control of the off-gas. The LFG off-gas treatment systems, if incorporated, usually involve more complex control schemes.

8.7.2 Automatic Operation

The degree of automation incorporated into the system design is generally dependent upon the complexity of the treatment system, the remoteness of the site, and monitoring and control requirements. An evaluation (trade-off) is usually carried out to compare the initial capital cost of the instrumentation and control equipment and the labor cost savings in system operation.

8.7.3 Unattended Operation

Systems designed for unattended operation would incorporate the greatest degree of automation of system controls. Control schemes may include the use of remotely located PLCs, remote data acquisition, modems, and radio telemetry. System mechanical and electrical components would be selected on the basis of optimum reliability while requiring minimum maintenance and adjustment.

8.8 OPERATION CONCERNS

8.8.1 Equipment quality Problems

Technical problems associated with equipment when used for LFG applications can result due to chlorinated and toxic compounds, particulates, and reduced heating value.

Component malfunctions or breakdowns are undesirable but nevertheless inevitable during the operating lifetime of an LFG recovery system. The best way to react to these setbacks is through a rigorous O&M plan, which not only prevents many problems that might arise out of neglect, but also allows the operator to anticipate, through performance trends, when a particular component is likely to break down. In such a case, the operator can plan ahead by taking the proper measures, whether it be calling a vendor for service or ordering a new part. In this manner, lengthy shutdowns can be largely avoided.

8.8.2 Climate

Climate can play a large role in the day-to-day operation of an LFG system. Temperature fluctuations can result in the natural production of more or less CH_4, which can cause blowers and treatment systems to perform inefficiently. If the landfill is not adequately capped, periods of heavy precipitation can lead to the removal of large volumes of water along with the gas. This water can be harmful to the blowers if not removed, and may require treatment before discharge.

8.8.3 Vandalism

Wellheads and valves should not be exposed to the dangers of tampering, vandalism, or accidental damage. They should be protected by lockable covers with either removable or lockable valve handles.

8.8.4 State Laws

The operator of an LFG facility must know applicable state laws. Most states set their own programs. Many states have regulations more stringent than those in RCRA. A facility can be in compliance with RCRA and still in violation of state law.

8.9 MAINTENANCE REQUIREMENTS

The operation and maintenance (O&M) of an LFG management system should be structured to maintain the operation goals (i.e., 98 percent reduction of NMOC). An O&M program can be divided into the following categories:

- routine O&M;
- non-routine maintenance, and
- emergency services.

8.9.1 Routine Maintenance

A routine inspection of the entire system should be performed on a regular basis, with the interval depending on the specific system. For example, maintenance and inspection at the blower/flare station is performed weekly. During the inspection, the integrity of the wells and header piping should be visually checked and any damage noted. Pressure and temperature data should also be collected and maintained for key locations throughout the process.

A Routine maintenance program includes periodic maintenance and preventive maintenance.

Periodic maintenance includes testing and checking of the following components:

- extraction wells,
- collection header,
- monitoring wells and probes,
- oil change on blower,
- flame arrestor cleaning,
- condensate handling,
- gas detection system, and
- pilot/auxiliary fuel.

Pilot/auxiliary fuel refilling and equipment cleaning should be performed at least weekly. In particular, the combustion mechanism will require regular cleaning to assure that the gases are burned completely. Air and oil filters should be checked and changed routinely after a certain number of hours as recommended by the manufacturers. This will prevent more costly and time-consuming repairs down the line.

Preventive maintenance includes:

- blower bearing lubrication,
- flame sensor cleaning, and
- blower/flare station components.

Regular oil and lubrication changes should also be performed on the blower, compressor, gear box and combustion systems. This will help ensure that the process operates smoothly and efficiently, and it also reduces the chance of costly downtime associated with larger repairs.

8.9.2 Non-routine Maintenance

Non-routine maintenance activities consist of corrective repair or maintenance work identified during the routine inspection. These may include:

- repair or replace failing components,
- testing and adjusting collection system if air intrusion is observed.

8.9.3 Emergence Services

Emergency services are those requiring immediate response to prevent human injury, property damage, or regulatory non-compliance. These activities may include:

- responding to system failure or shut down,
- execute contingency plans, if required.

8.9.4 Equipment Calibration

The instruments used for measurements are customarily correct to within a certain percentage of the "true" value. This accuracy is generally expressed by the instrument's manufacturer as the "inherent error of the device." Instrument calibration does not lead to elimination of error; it does allow the equipment to provide representative numbers for the subject measurement to the best of the machinery's ability. Routine calibration and servicing are necessary to assure the quality of measurements made using these instruments. Permanently installed equipment used for measurements of record should be calibrated according to manufacturer's recommendations and quality assurance program.

8.9.5 System Adjustment Based on Monitoring Data

Landfill operators have to adopt a variety of monitoring parameters, techniques, and frequencies to balance the vacuum system so as to collect as much gas as practicable and or contain the LFG in all parts of the landfill. For example, the gas flow rate at the station may need to be adjusted due to landfill aging and greater gas generation. Adjustments of flow rate are usually accomplished by partially opening or closing the valve on the blower inlet side.

8.10 SAFETY CONSIDERATIONS

Appropriate safety and health procedures shall be developed and followed for all aspects of LFG recovery installation and operation. The applicability of 29 CFR 1910.120(b) and 29 CFR 1926.65(b) should be determined before enforcing the requirements of this paragraph. Both the contractor and U.S. Army Corps of Engineers (USACE) personnel shall comply with all applicable 29 CFR 1910 and 1926 standards requirements for a contractor Safety and Health Program (SHP) and a Site-Specific Safety and Health Plan (SSHP). The SSHP shall also be developed in accordance with ER 385-1-92. In conjunction with federal regulation compliance, the contractor and USACE personnel shall comply with all pertinent provisions of USACE Safety and Health Requirements Manual, EM 385-1-1. Where there is overlap between the federal requirements and USACE requirements, the contractor shall adhere to the more stringent. In certain instances, state and/or local safety and health requirements may also be applicable. In those instances, the contractor shall be responsible for the knowledge of and compliance with the state and/or local requirements. In all cases, the most stringent of the regulations shall apply.

The SSHP monitoring provisions shall include work area monitoring for the presence of explosive gases which may endanger workers, and otherwise, for the presence of any O_2 depleting or 0_2-displacing gases. The explosive/inert gas monitoring is in addition to the site-specific worker exposure monitoring to be identified in the SSHP for the project. The SSHP provisions shall give special consideration to other safety and health issues unique to LFG applications, including, but not limited to, noise protection (especially around the blowers), adequate

ventilation (for indoor blower housings), and temperature extremes (especially during periods of unusually warm or cold weather).

The following guidelines should be followed when working at a landfill in the presence of potentially dangerous gases:

- No person should enter a vault or a trench on a landfill without first checking for the presence of CH_4, $C0_2$ or other toxic gases. The person should also wear a safety harness with a second person standing by to pull him or her to safety.

- Anyone installing wells in a landfill should wear a safety rope to prevent from falling in the borehole. Open holes should be covered when they are left unattended.

- Smoking should be prohibited on the landfill where drilling, excavation, or installation of equipment is taking place or where gas is venting from the landfill.

- Collected gas from a mechanically evacuated system should always be cleared to minimize air pollution and any potential explosion or fire hazard.

- CH_4 gas in a concentration of 5 to 15 percent is an explosive mixture. Gas accumulations should be monitored in an enclosed structure to insure that explosive conditions are avoided, and if detected, appropriate response is taken to avoid a source of ignition and to vent the structure.

All personnel working on the landfill must be provided training regarding the dangers posed by LFG. Personnel operating safety equipment around the landfill must be thoroughly trained in its use and have a clear understanding of the meaning of observations made with the monitoring equipment. Monitoring equipment must also be periodically calibrated to ensure continued accuracy in the results.